The Parataxonomist Revolution:
How a group of rural Costa Ricans discovered 10,000 new species

by

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Submitted to the Program in Comparative Media Studies/Writing
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ABSTRACT

In northwestern Costa Rica, a team of rural workers called parataxonomists has been inventorying butterfly and moth species for 30 years. Just as a paramedic provides a first round of medical care, a parataxonomist does the on-the-ground work of taxonomy—collection, preparation and data gathering—before sending a specimen on to be analyzed. The parataxonomy program, led by biologists Daniel Janzen and Winnie Hallwachs, is part of the unique conservation model of Costa Rica's Área de Conservación Guanacaste (ACG).

Hiring local people, rather than students or academics, as permanent field researchers upset traditional research structures, but has paid off for science and for local communities. Some 10,000 new species have been identified through these efforts. The parataxonomists benefit from steady employment in areas of little economic opportunity, and in turn serve as a voice for conservation in their communities. But even as the parataxonomy model is praised abroad—and is being adopted in other countries—its future in Costa Rica is tenuous.

This thesis looks at the lives of the parataxonomists of the ACG and the impact of their work. It explores the rise and fall of Costa Rica's National Biodiversity Institute (INBio) and the state of parataxonomy as a model for research and conservation.

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Robin Kazmier

Carolina Cano crosses the empty floor of a low, wide barn in Guanacaste, Costa Rica, softly tapping a series of 75 puffed-up plastic bags attached to strings drawn between two rafters. Each one is scrawled with an ID number, species name, and collection date in black marker. Cano, a stout 45-year old woman, seems to be moving too quickly to see inside the bags, but when one of her taps causes a tiny flutter, she unclips the bag and takes it with her.

The barn is part of the San Gerardo Biological Station, a converted farm property off a muddy road up the mountain from the town it's named after. A cool wind blows through one open side, sending hundreds of bags bobbing on their lines, each gently weighted by a few leaves and a single caterpillar plucked from the nearby forest. Cano zips up her jacket and pulls her coarse, black hair into a ponytail, which accentuates a few silver strands and exposes her small pearl earrings. She gathers the bags containing newly emerged butterflies and leaves the barn, closing the wooden gate behind her.

Outside, the overcast sky hints at rain, and palm and waxy-leafed citrus trees rustle in the breeze. Cano walks over to a boxy, yellow concrete house, where she marks each bag with the date before dropping them into a chest freezer so the butterflies die before they damage their wings on the bag. As Cano works, laughter comes from the kitchen, where the rest of her four-person team is clearing breakfast dishes and preparing for the morning's collecting trip. In a few minutes, they'll put on jackets and rubber boots, strap on fanny packs full of neatly folded plastic bags and trimming snips, and head out the back door into the rainforest.

The banter of the group feels more like family than coworkers, which is no surprise, given that some of them *are* family. Gloria Sihézar and her longtime partner, Osvaldo Espinoza, met on the job a quarter-century ago, when she was 17 and he was 23. They spent their first years as a couple living at the biological station to be closer to their work. "My son learned to crawl here," Sihézar says. Elda Araya, Sihézar's aunt, is the veteran of the group, with 30 years' experience. None of the workers live at the station anymore; instead, the group gathers here each morning of their 20-day shifts.

Cano and her team are just a fraction of the 34 active parataxonomists that work in a large protected area in northwestern Costa Rica known as Área de Conservación (ACG). Just as a paramedic provides immediate care before sending a patient to a hospital, a parataxonomist does the on-the-ground work of taxonomy—collection, preparation and data gathering—before sending a specimen on to be analyzed. The parataxonomists are scattered across 11 biological stations in the ACG, spread over areas ranging from sweltering rainforests to blustery volcanic peaks. Combined, they have discovered some 10,000 new species over the past 30 years.

Parataxonomy—and to a large extent the ACG itself—is the brainchild of a 78-year-old North American ecologist named Daniel Janzen, who divides his time between Costa Rica and the University of Pennsylvania, where he is a biology professor. Parataxonomists play a key role in the experimental conservation strategy that he and biologist Winnie Hallwachs, his research partner and wife, have worked to implement in the ACG since the 1980s. The underlying philosophy is that a wild area will only survive if it is an integrated, economically self-sustaining part of society, rather than a fenced-off conservation district. But before that can happen, Janzen says, you have to know what species are on the land to begin with.

The parataxonomists who work in the ACG come almost entirely from the small farming towns surrounding the conservation area, and many have dedicated over 20 years of their lives to carrying out a systematic inventory of local insect and plant species. Like

Sihézar and Espinoza, those based at hard-to-reach biological stations have often opted to live at their stations for years at a time. There they've raised their children among a rotating cast of caterpillars, with all the freedom and isolation of the jungle.

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In 1962, Daniel Janzen was a 23-year-old biology grad student working in Veracruz, Mexico, and he needed help. He was researching the relationship between acacia trees and the ants that live in their hollow thorns. It was strenuous, time-consuming work. One day, he met a teenage goat herder named Cayo, who was wearing a necklace made of the plastic rings that Janzen had been using to meticulously mark the area's trees. The two got to talking, and after learning about Janzen's work, Cayo continued on his way. Soon, however, he was back, with a thorny branch and a long list of questions. Janzen was both impressed and intrigued. After talking with Cayo's father in the family's dirt-floor home, Janzen hired the boy for a salary of $7 per week.

Cayo quickly proved himself to be an excellent worker. Janzen completed his PhD. in 1965 and eventually focused his research in Costa Rica. Again, he looked to the local community for help. He soon discovered that many locals, regardless of their educational background, were more effective in the field than visiting graduate students.

For much of the next two decades, Janzen's research focused on Costa Rica—primarily Santa Rosa National Park, in what is now the ACG. In 1985, the director of the park system asked him for help with a problem on the country's southern Pacific coast, where local miners were simultaneously damaging the land and putting international funding for one of the country's national parks at risk. When Janzen visited the miners, he learned that they viewed the parkland as ownerless and unused.

His work helping park officials initiate the peaceful removal of the miners resulted in Janzen becoming "a changed man," according to Hallwachs. The trip had opened his eyes to the fact that anytime a protected area was seen as being underutilized by the surrounding communities, it would likely face threats like mining, logging or hunting. "I realized that if land was going to be conserved, it had to be done a different way," Janzen says, "not with a gun and gold badge."

The idea he came up with was simple, but revolutionary for its time: integrate wild lands with the local communities in such a way that an intact forest becomes a valuable resource. In 1986, he wrote up a detailed plan for Guanacaste's protected areas to serve as a test case for his new approach. The project quickly gained the support of Costa Rica's president and many senior decision-makers as well as some of the country's key conservationists and biologists.

Janzen's first priority was to restore the area's tropical dry forest—a highly endangered forest type that had all but disappeared from the Americas. He began fundraising at a breakneck pace, bringing in hefty grants and donations from around the world. The soft-spoken Hallwachs juggled her own research with her new supporting role as Janzen threw himself into the project. "My heart really got into when we added Costa Ricans to our team," she says.

Within three years, Janzen had raised over $50 million, $11.5 million of which was used for an endowment of the "Guanacaste project." The project, which would eventually become the ACG, became the first endowed government-protected area in the world.

With continued support from the Costa Rican government, Janzen and Hallwachs built the ACG by gradually buying some 350 farms that would link together existing protected areas. The ACG is now a 640-square-mile tract that connects four major ecosystems and three national parks. In 1989, Janzen was awarded a MacArthur "genius" Fellowship for his work in restoration ecology. As with the many awards that would follow, he funneled the $350,000 he received from the MacArthur Foundation to the ACG.

Operating as unpaid technical advisors, Janzen and Hallwachs worked with the growing ACG staff to hire and train a team of firefighters, create a biology education program that brought schoolchildren into the conservation area, and make the area amenable to researchers who wanted to do field work. But when it came to knowing exactly what was living in Costa Rica's protected areas, Janzen's vision extended far beyond the borders of ACG.

Janzen had begun a butterfly and moth inventory in the area with the help of Araya and a few other early parataxonomists, and as the new conservation plan took shape, he and Hallwachs developed a formal parataxonomy course. The United States Agency for International Development provided $120,000 for the first six-month course. Janzen says he interviewed applicants as he would graduate students. They would need to be highly independent and eager to learn the names of countless species while collecting and pinning thousands of insects per month. And, crucially, they would need to be content living and working in often-harsh field conditions, with little contact from support staff. Beyond basic literacy, formal education wasn't as important as a strong desire to step into the role and learn along the way.

The first course began in January 1989 and its 15 participants included park service employees from across the country. Araya was one of only two female participants in the first class, which spent grueling 10- to 14-hour days learning everything from using a chain saw and reading a map to biology and conservation philosophy. Janzen ran the course three times; Cano was a member of the final class, in 1992. From that point on, the ACG parataxonomists were trained by working as apprentices to those who had come before them.

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When the parataxonomists from the San Gerardo Biological Station enter the forest, it's Araya and Espinoza who take the lead, scattering off to the sides of the trail. This year, per Janzen's instructions, the parataxonomists are only collecting larvae from a single family of butterflies, known as skippers. As Espinoza picks up a smattering of tattered leaves, he explains how the bite patterns reveal what kind of caterpillar had been feasting and how long ago the meal had occurred, rattling off plant-butterfly species pairings and explaining not only different caterpillars' feeding tactics but how and where in the ACG those tactics were first discovered. The larvae of skippers, or Hersperiidae, make their presence known not by how they eat the leaves but by how they manipulate them.

"They make little houses," says Cano, reaching for a nearby leaf to demonstrate how they bite and fold the leaves around themselves, forming little tent-like pouches secured with

silk. What might look to most like a regular pair of leaves hanging off a shrub in a sea of green is a dead giveaway to Cano, who can tell that a skipper larva is sandwiched in between them.

Spotting one of these subtle hideouts, she snips the stems of the two leaves and places them in a plastic bag with a few extra leaves. She flicks the bag wide open to fill it with air before tying it shut and attaching to her belt. A few meters ahead, Araya is standing in a stream scanning the leaves overhead, a half-dozen bags ballooning out from her waist. The emerging sunlight glints off the reading glasses that hang from her neck, completing her grandmotherly look, which is only appropriate: The 56-year-old Araya, or Doña Elda, as she is respectfully known, has been doing field work for Janzen's research since 1987, two years before the formal creation of the parataxonomy program.

Back at the San Gerardo station, Cano and her team unload the morning's haul and prepare a lunch of rice, black beans and salad. Lunch leads to afternoon coffee and as the wind kicks up, the group reminisces about the early days of the program.

"The hardest thing when I started was just seeing the larvae," Cano says. Sihézar nods and says that early on, she was riding in a car with parataxonomists who would shout for the driver to stop because they had spotted a caterpillar on a branch they had just passed by. "I thought *my God, how do they do that?*" she says. "And then one day you do it."

At first, Sihézar was actually afraid of the small insects, but before long she'd realized she'd begun to feel affection for them. One day she saw a caterpillar with beautiful, soft hairs and was so taken with it that she gently brushed it against her face. That was how she discovered that those hairs sting—they were the caterpillar's first line of defense—and the group roars as she tells of the painful rash it left on her cheek. Her challenges were not unique: virtually all of the parataxonomists initially struggled with everything from identifying plants to using laptops. But in time, they came not only to know hundreds of species of plants and caterpillars but also to recognize the interactions between species in the forest.

They know there is a caterpillar that can eat its way up through a tree trunk, and the only evidence is the bit of feces it uses to plug the holes where it occasionally emerges from a branch. When they see a certain half-eaten leaf lying on the ground, having been neatly severed at the stem, they know what kind of caterpillar is in the tree above, trying to eliminate evidence of its meal so as not to tip off predators. They know of such habits and partnerships because, in many cases, they discovered them.

"With our work we're completing information," Cano says. She explains that they go beyond simply identifying new species. In collecting and rearing caterpillars, they try to capture the whole story of each species: what the larva eats, what it looks like at every stage, how long it takes to pupate, what parasitizes it.

"A lot of specimens, a lot information that gets to biologists, to scientists—it's from us," Sihézar says. "We're the ones down here making sure the product gets to those people."

"And we don't have a high school diploma between us," Cano says.

For all their discoveries, however, the San Gerardo group speaks most fondly of sharing knowledge in the community. "It feels good to teach people, just like we learned, that a butterfly comes from a caterpillar," Sihézar says. "A lot of people tell us they don't kill caterpillars anymore now that they know a butterfly comes from it."

Indeed, learning is a topic they come back to over and over. Most locals didn't understand what the parataxonomists were doing at first, but now, some flag them down to hand off a caterpillar they gathered from their yard or discovered on a houseplant. (The collector's name is then duly added to the specimen's record.) Sihézar says that when she and Espinoza moved to this station, their first friend in the area was a kid who took an interest in their work and would often show up to go collecting with them. He ended up collecting the first specimen of a species previously unknown at the San Gerardo site.

Over the years, children have gone to the San Gerardo parataxonomists for help with school projects. One year, Sihézar took caterpillars to her daughter's school and helped the students repeat the rearing process in their classroom. Many of the parataxonomists are adamant about their kids continuing their education for as long as possible—and some point to the fact that each team is issued a laptop as a major benefit. The 21-year-old son of two parataxonomists from another site is a semester away from graduating from college with a degree in business computing, which he credits to the fact that he had access to an ACG laptop as a child.

Janzen points out that at these remote stations, the parataxonomists are the only official ACG presence. According to Janzen, the fact that they're part of the community makes the ACG a "friendly neighbor" and, more importantly, a source of jobs. "This place doesn't exist because the neighbors see the parataxonomists being happy collecting insects," he says. "They see this as a place that employs 150 people and spends five million dollars a year on a local basis."

That's not to say ACG has no critics. Some residents complain that if the land were used for farming instead, there would be more jobs. And parataxonomists occasionally find themselves in the uncomfortable position of confronting friends and neighbors about hunting or cutting down trees. But this is exactly the kind of integration Janzen has touted: the call to protect the land is coming from neighbors in the community, not as a mandate from the government.

Almost all the parataxonomists say that the best thing about the job is that it's stable. The pay isn't great, but it's consistent. There are few opportunities in Costa Rica's rural communities, and fewer still for women, particularly without a high school diploma.

"I honestly don't know what I would be doing if this job hadn't come along," Cano says. Araya guesses she would have been a housewife, Espinoza a fisherman or a cop.

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Taxonomy, the science of classifying and naming organisms, doesn't attract much funding. Taxonomists themselves are often described as an endangered species.

The discovery of a new species—be it a shimmering beetle or tiny "zombie" wasp—is often reported as an exciting and rare event. But the 2 million species known to science make up, by some estimates, less than 20% of the total species on Earth. As biologist E. O. Wilson writes in his 2016 book *Half-Earth*, "The truth is that new species flood museums and laboratories everywhere, all the time." Most of the time, specimens wait on a shelf for a decade or more before being analyzed and described.

This bottleneck of discovery delays taxonomy's mission: a name. Without that, a species is invisible to human society. When scientists argue in favor of conservation, they

deal in hypothetical species and warn of the collapse of food webs they only partially understand.

Wilson stresses that without the most basic information about an ecosystem—the species it contains, and how they interact—it's impossible to know what its tipping point is or how close we are to it. And by Janzen's use it or lose it approach, this basic information is the foundation for using wild areas in a non-damaging way. But, Wilson writes, the rate of habitat destruction and "obliteration of countless unknown species" far outpaces classification efforts. "Most people are unaware that this unfinished mission of science to discover and conserve all of life on Earth even exists," he writes.

Janzen thinks parataxonomy is key to that unfinished mission. Taxonomists traditionally focus on narrow groups of species (say, one genus of ants), and work to understand a group as it exists across the entire world: their work is to piece together a family tree. Parataxonomists, on the other hand, work in one location, gathering specimens and data about everything there so as to understand the populations and workings of a whole ecosystem. But, Janzen says, to connect their work with the rest of the scientific community requires an intermediary institution whose staff can receive the parataxonomists' specimens and reach out to the taxonomic community for help sorting out the species.

In 1989, Janzen and Hallwachs worked with Costa Rican biologists to create the National Biodiversity Institute (INBio), which would serve as a research center, in part by processing and housing the specimens that the parataxonomists collected. INBio, which was set just outside the capital city of San José, aimed to catalog all of Costa Rica's life forms. It essentially scaled up the model Janzen introduced with his butterfly and moth inventory, extending it across the country and across insect and plant families. INBio eventually trained about a hundred new parataxonomists to collect insects and plants in the national parks.

It wasn't always easy in Costa Rica's macho culture for the park guards-turned-parataxonomists to trade in their guns for butterfly nets. The parataxonomists would arrive at INBio from their stations across the country with as many as five large boxes full of pinned insects. The specimens were taken through an assembly line of sorts, first being assigned individual barcodes on a tiny ticket, then sorted into narrower and narrower groups, with detailed natural history information entered into every specimen's digital record.

The barcode and database systems, masterminded by Hallwachs, brought order to the mass of specimens that had been collected. For biologists, the system's efficiency and user-friendliness was a major draw, a quantum leap forward from the traditional method, which involved little more than a label with a date and location marked on it. Researchers could gather up insects, scan their tickets with a barcode reader, and immediately access the specimens' full data and detailed natural history information. Entering new data was just as easy. Visiting biologists could stay in simple bunks on site for a few dollars a night, just steps from the INBio lab and collection. They helped the curators identify challenging species and picked out specimens they wanted to borrow for research back at their home institutions.

In 1990 alone, INBio processed 1.5 million specimens. (Janzen was fond of pointing out—to the annoyance of some local biologists—that the institute had far exceeded in one year the collection compiled by the Costa Rican National Museum over its 100-year history.) It received awards for biodiversity management and drew scientists from around the world eager to dig into Costa Rica's new collection.

"Everyone was connected," says Isidro Chacón, a former parataxonomist who also helped curate the collection. "The techs learned from the curators. And everyone would gather together for sessions with the parataxonomists to answer their questions about rare species and give them feedback on their work."

Ronald Zúñiga, who came to INBio as a technician, remembers the atmosphere of learning and collaboration. "The art of the whole system was to learn by doing," he says. "Often the most direct relations were between the [visiting] biologist and the parataxonomist." If a particular specimen intrigued a biologist, he might travel with the parataxonomist to the place it was collected. "And the parataxonomist was really the only one who could write even a line of natural history for the biologist," he says.

Entomologist Terry Erwin, a beetle expert and curator of the beetle collection at the Smithsonian Museum of Natural History, made frequent trips to INBio in the 1990s and early 2000s. "There was always a lot of traffic," Erwin says. "People coming in, going out, heading for the field, bringing stuff back." He often found himself working alongside four or five other beetle experts at the rows of tables in INBio's sprawling lab—each examining specimens from their area of expertise.

Having a centralized collection and coordinated research efforts eliminated many of the hassles that came with taxonomic work. Taxonomists could bypass the steps of getting permits, doing field collection, and cataloging specimens themselves, and instead land in Costa Rica and go straight to INBio—an hour's drive from the airport—and start working immediately. If they wanted to venture into the field, they had the parataxonomists and research stations at their disposal, but for many it was no longer necessary. "[The system] benefited my research," Erwin says, "which in turn benefited the knowledge of the beetle fauna of Costa Rica."

It was more than just convenient. The INBio system allowed Erwin to do research he couldn't have afforded to otherwise. Because of arcane government funding rules, most Smithsonian scientists aren't allowed to seek funding from the National Science Foundation. With an annual budget of $2,000 for curating the 12 million beetle specimens in his care at the Smithsonian, Erwin didn't have much money left over for actual taxonomic research, much less collecting trips abroad.

"The shortcut in Costa Rica was the parataxonomists doing all that front-loading and I could just get the specimens and go right to publication," Erwin says. "For the Smithsonian people not having very much money, it was really excellent. It was like getting a nice grant to work in Costa Rica," he said.

But for Rita Vargas, a biologist and coordinator of the Zoology Museum at the University of Costa Rica (UCR), INBio seemed like a threat. "We saw it as competition," she says. INBio was a private, non-profit organization; Vargas says the fact that it called itself a "national" institute and represented Costa Rica at important meetings didn't seem right. In addition, the rumored lavish salary of INBio's director, a Costa Rican agronomist who'd previously been involved in biodiversity efforts, was offensive to public employees, Vargas said.

Jorge Cortés, another UCR biologist, says INBio representatives belittled public institutions like the UCR and the National Museum in order to make themselves look better to donors. Both Vargas and Cortés say the result was massive resentment toward INBio in academic circles. For his part, Janzen thought that resentment stemmed from the fact that

INBio was getting a great deal of funding and praise for doing work the UCR *should* have been doing all along. On top of the competitive threat of the institute, Janzen says UCR biologists were angry that INBio was giving jobs to uneducated locals instead of graduate students.

Pedro León, president of the National Academy of Sciences of Costa Rica, has supported INBio since it was founded. "INBio was created with the idea that we need to know what we have before we lose it," he says. "[Parataxonomy] seems to me such a great idea, that it was very disappointing to learn that the school of biologists was against it because they saw it as a threat to their biologists," says León, who is himself a former UCR biologist.

León points out that people simply misunderstood what the parataxonomists were. They weren't taking any biologists' jobs, he stresses, because no biologist wants to live in the field permanently, focused only on collecting.

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In spite of its mixed reception in Costa Rica, INBio seemed poised to show the world that conservation could pay for itself. In 1991, it entered into a bio-prospecting agreement with the pharmaceutical company Merck. The agreement gave Merck access to chemical compounds and data from the collection for $1.1 million per year and rights to royalties from any products developed from INBio samples and information. At the time, some claimed that INBio was selling off Costa Rica's biodiversity, but many conservationists praised the deal as a model to aspire to, pointing out that Merck was paying for something many companies take for free. In 1996, officials from Yellowstone National Park visited INBio to learn about its bio-prospecting agreements, which they eventually used as a model for Yellowstone's first bio-prospecting deal.

But the deal didn't result in any major windfalls, and Merck exited in 1998 after failing to find a single usable chemical. (INBio entered into other, lower profile bio-prospecting agreements over the years, and while some useful compounds were identified, no blockbusters or major moneymakers have been developed.) Around the same time, an ambitious 10-year biodiversity inventory of ACG was cancelled because of political issues and, in 1997, Janzen and INBio parted ways.

As the years went on, INBio had more difficulty raising money, and by the late 1990s, it had begun laying off parataxonomists. Whenever he could, Janzen would pay the laid-off workers out of his own pocket to work on a butterfly and moth inventory in the ACG. Finally, in 2015, after a failed attempt to make money through a biodiversity theme park, INBio went under. Ownership of its collection was handed over to the National Museum of Costa Rica, although it remains in the old INBio facility.

The National Museum chose not to retain any INBio employees when it took over. Janzen and Hallwachs were loath to see people like Chacón and Zúñiga, who were part of the parataxonomy effort and had managed the collection for so long, out of work, their expertise lost. So once again, they paid these fired workers' salaries themselves. The pair funds a handful of former INBio employees, but those people work separately from the National Museum's staff, almost as if they were guests in the facility. Chacón and Zúñiga quietly maintain the collection, keeping an eye on new publications and updating taxonomic labels on

the thousands of wooden drawers housed in row after row of 8-foot-tall metal cupboards. Across the hall, the dim, empty lab is silent.

"The collection is dead," Chacón says, referring to the fact that there are no new specimens coming in. The butterflies reared by parataxonomists in ACG are mostly distributed across other institutions. Zúñiga says it's been eight years since biologists came to use the INBio collection. He says when they fired the parataxonomists the specimens stopped coming, and so did the scientists.

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Stepping over to a desk, Cano lifts open her team's MacBook and opens FileMaker Pro. She creates records for the 15 or so caterpillars collected that morning, filling in the date, trail, name of the collector, plant species, and caterpillar species for each one. She marks the bags with the same information, plus the record number, and takes them out to the barn where they join the others.

Tomorrow the group will make a "grocery list" of the plant species in all the caterpillars' bags, then go into the forest and bring fresh leaves of the same species. The food needs to be changed every five days until a caterpillar reaches prepupa, the inactive stage before it builds its cocoon, which can take up to three months.

But after all that careful tending, the payoff might not be a butterfly at all. Some caterpillars will go limp, sprouting dozens of tiny cocoons from their bodies. Those, it turns out, had been injected with the eggs of a parasitoid wasp before they were collected, and the larvae eventually ate their way out of the caterpillar, killing it in the process. The tiny parasitoids, once they emerge, are frozen and documented as well.

This part of the work hasn't changed much since the program started, but both the parataxonomists' additional duties and the technology available to them has evolved over the decades. In addition to maintaining a species database, they also photograph the specimens and write extensive "species pages," essentially an online field guide. The pages, of which there are now over 500 on the ACG website, detail the natural history of a butterfly species: physical description, habitat, food, variations, length of pupal stage, and so on.

Many parataxonomists, unaccustomed to writing at length and self-conscious about their spelling and grammar, were initially reticent about composing the pages, but ACG staffers help them polish their work. At a recent workshop, they learned how to edit videos in iMovie, in hopes that the encounters they capture with their cell phones can be shared online as well.

A few of the parataxonomists are dedicated to preparing samples of butterfly and parasitoid legs for a process that didn't exist when the program began: DNA barcoding. Janzen sends large batches of the samples to the Biodiversity Institute of Ontario each year. There, a short portion of each sample's genome is sequenced. The resulting "barcodes" have revealed that many "known" species are in fact a complex of species, Janzen says. As DNA analysis shifts our understanding of species, Janzen sees more value than ever in the kinds of large collections made possible by parataxonomists.

Janzen has often envisioned the ACG and its programs as pilot projects for the greater conservation community. Despite the political and financial challenges parataxonomy has faced, enthusiasm for the model has caught on. In 2014, ACG received a donation to fund two

new parataxonomists in its marine sector. UCR biologists Jorge Cortés and Rita Vargas, who'd resented INBio when it was launched, are now co-leaders of the marine effort. The newest parataxonomists—a former fisherman and a housewife from a coastal village—spend long days and nights collecting, documenting and keeping meticulous records of mollusks and other species from the nearby waters.

The model has spread to other countries as well. Scott Miller, an entomologist and curator of the butterfly collection at the Smithsonian Museum of Natural History, co-leads a parataxonomy program in Papua New Guinea. That program faces an entirely different set of challenges: According to Miller, the country's traditional land tenure system makes land ownership extremely difficult to understand and navigate.

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On a hot January evening in Guanacaste, Janzen and Hallwachs sit in plastic chairs under a corrugated tin overhang and a bare light bulb outside their cluttered, simple home in Santa Rosa National Park, sharing stories about the parataxonomy program long into the night. Walking through a timeline of the program, they quibble over specific dates, and laugh about the blunders from the early years of the program when they were learning how to navigate Costa Rican culture and politics and the parataxonomists were learning how to do field biology, everyone out of their element. Janzen is happy to recount every step of the journey, but his single-minded focus cuts through any hint of nostalgia. The conversation swings back to the central problem.

"It's not sustainable," Janzen says. He's been working for years to convince the national park system that it's important to know what's inside a protected area, and thus to employ parataxonomists. That's what the entire INBio effort was about, he says, trying to make it so ACG wasn't exceptional, but was just part of a bigger system. "But we failed at that," he says.

The program continued successfully in ACG, separate from INBio, but was dealt a major blow in 2011, when the U.S.'s National Science Foundation discontinued its longstanding support of the parataxonomists' work. Blindsided by the withdrawal of funds, Janzen was scrambling for the millions needed to keep the program afloat when unexpected donors approached him and bailed the program out. Still, it's unclear whether that support will continue, and Janzen, who remains energetic but is unable to sustain the pace of his earlier years, still spends a great deal of his time fundraising for the program. He and Hallwachs also continue to donate over half of their earnings, including his salary from the University of Pennsylvania, to the parataxonomy program.

While Janzen talks about the national park system bringing on the parataxonomists, he knows that any new positions they funded would be for public employees. That means they would almost certainly come with the prerequisite of a high school diploma, disqualifying the vast majority of the parataxonomists working today.

"If we disappeared tomorrow, the park system would not support them," he says.

As has always been the case with ACG, there's no telling what will happen next. The end of the program would be the end of an important chapter in Costa Rica's conservation history, one whose ideas and impact have spread across the world. But it's worth noting that even if the parataxonomist jobs disappear, the local communities would still have the

parataxonomists themselves, their voice for conservation and deep knowledge of the forest. As Cano put it when explaining to a visiting biologist how she knew so much about the habits and lifecycle of a specific caterpillar:

"This isn't days. This is years."

Disclosure: The author first learned of the parataxonomy program from a close personal acquaintance, a part-time contractor with the ACG.

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